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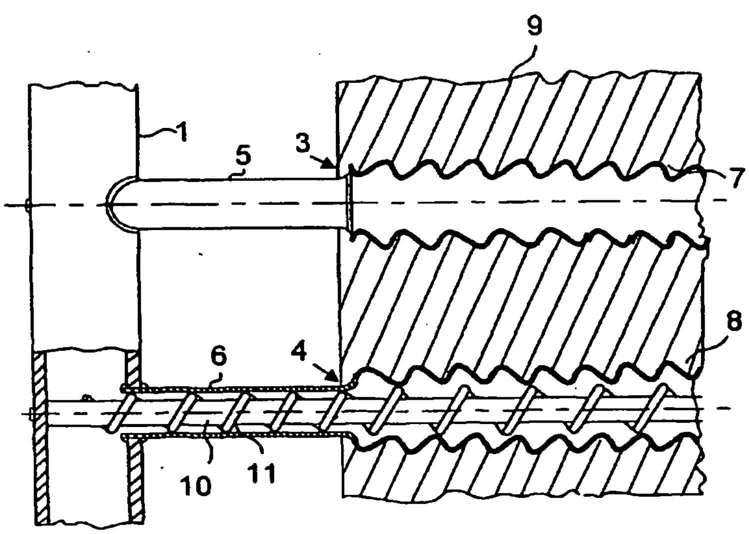
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: APPARATUS FOR HEAT TRANSPORT AWAY FROM HEATED ELEMENTS AND A METHOD FOR MANUFACTURING THE APPARATUS



(57) Abstract: An apparatus is provided for transporting away heat from heated elements. The apparatus comprises a block (9; 18; 27) of a material having good thermal conductivity on to which the elements are provided in thermal contact. Channels (7, 8; 17; 25) are provided in the block. A liquid, for example water, is forced to flow through the channels. The channels are made by tubes having thin walls and made by a non-corrosive material against the streaming liquid, such as steel, preferably acid proof stainless steel, or gold or silver. The tubes could be cast, or fastened in some other way, for example electroplated in half channels in two blocks to be firmly joined to each other, in a material having good thermal conductivity, for example aluminium. The material of the tubes could have less thermal conductivity than the material of the block.

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Apparatus for heat transport away from heated elements and a method for manufacturing the apparatus

This invention relates essentially to an apparatus for transporting away heat from heated elements as stated in the preamble in Claim 1, and a method for manufacturing the apparatus.

BACKGROUND

Electrical components most often generate heat when in operation. When the electrical components are power components, or there are many components within a small space, this heat is frequently transported away by so called cold plates, which are cooled with streaming water streaming in channels through them. Cooling with water is thus very often used at power amplifiers provided with semiconductor elements, HF-combiners, semiconductor diodes, and dummy loads for digital transmitters for DTTV (DTTV = Digital Terrestrial TeleVision), for example. However, the usefulness of the invention is not limited to such an application. Some other possible applications for it could be to cool heat-producing components enclosed in a housing and also other kinds of technical regions where a high cooling effect has to be combined with a good corrosion resistance.

RELATED ART

Modern DTTV transmitters have power amplifiers comprising semiconductor elements only. They should be cooled to a temperature as low as possible in order to obtain a long working life. The delivered power dissipation from each transmitter is in the order of 15 kW. It is appropriate to use cooling with water in stead of air, because cooling with water demands less space and operates more silently than cooling with air.

Most frequently, up to now, the components to be cooled have been mounted in mechanical thermal contact with a metal plate having internal water channels. Water in a continuous flow has been pumped through the cold plates. It absorbs heat from the components. The water is then led to a cooling structure, most often placed outdoors. This cooling construction could be a conventional fan cooler. It is also possible to have collector tubes mounted down into and up through bore holes in the bedrock, through which the water is pumped.

A common type of prior art cold plate on the market is made by aluminium. In order to create a high capacity of the cooling of semiconductor elements screwed on the cold plates the water channels are provided with milled pins, which provide an extended surface towards the streaming water. The space between the pins is small, ca. 1 mm.

From the thermal point of view, aluminium is an appropriate material with a good thermal conductivity and thermal diffusivity. Aluminium has also a low density, which is advantageous since the cold plates often are mounted on extensible units, which ought to be disconnected from the transmitter to be carried away to a workbench by a single person.

In EP 0 903 971 A1 a cold plate of metal is provided on its internal surface with a series of selectively arranged dissipation fins. The plate is sealed by a lid, which by means of several longitudinal baffles create a number of internal ducts, in which a cooling liquid circulates. The fins are provided in "bunches" on the internal surface of the plate only at the points where the electronic components to cool are mounted on the external surface. Nothing is mentioned about what kind of metal the cold plate is made of.

In EP 0715352 A1 a substrate having a high cooling efficiency is disclosed. The substrate, which has a high heat-dissipating property, has a high thermal conductivity layer in which a cooling medium flow path is arranged. The material in the sub-

strate is for example poly-crystal Si. The high thermal conductivity layer is for example diamond.

In US 4,747,450 describes as prior art a block of a heat-conductive material, such as copper or aluminium, in which a passage may be formed by use of a tube, which also is made of copper or aluminium, i.e. a good thermal conductive material. The thickness of the tube is not discussed.

PROBLEMS WITH THE PRIOR ART

The cooling properties of the prior art cold plates are not good enough and need be improved.

A passive oxide layer is normally formed on aluminium surfaces. This layer protects the surface against corrosion but this has not been functioning for channels in cold plates of aluminium when in operation. After a few months operation corrosion has been obtained which obstructs the channels, and the components have therefore not been adequately cooled and have therefore been too hot. Use of de-ionizated water having an additive of corrosion protecting substance has not been enough to avoid this problem. It is to be noted that there is a demand for a long lifetime without interruption for the cold plate.

OBJECTS OF THE INVENTION

An object of the invention is to provide an apparatus for achieving an effective cooling of heated components by means of liquid.

Another object of the invention is to provide an apparatus for cooling heated components by means of liquid, preferably water, flowing in channels without any noticeable corrosion of the inside of the channels, i.e. to provide a cold plate with a long lifetime.

Yet another object of the invention is to provide an apparatus for cooling heated components, in which the excellent thermal conductivity and low density properties of aluminium can be used without having the in-advantageous feature of corrosion of the water channels.

An object of the invention is to provide a method for manufacture an effective apparatus for cooling heated components by means of a liquid.

Still another object of the invention is to provide an apparatus for providing different cooling for different components.

INVENTION

The invention relates to an apparatus for transporting away heat from heated elements, comprising a block of a material having good thermal conductivity on to which the elements are provided in thermal contact, and channels in the block, through which a liquid flows. The invention is characterized in that the channels are made by tubes in another material than the material in the block, the other material being non-corrosive against the liquid. Therefore, the channel tubes have thin walls and could be made of a material having less thermal conductivity than the material in the block. The tubes are in close contact with the material having good thermal conductivity.

Preferably, the tubes are made by steel, preferably acid proof stainless steel and also that the material having good thermal conductivity is aluminium. The tubes of non-corrosive material could be cast or sintered, plated, such as electroplated, or compacted by powder in the material having good thermal conductivity. The tubes could have an extended cooling surface for the heat transport by the liquid. The extended cooling surface could be provided by having the tube corrugated. The tubes could comprise core bar means in its centre and means for conveying the liquid in spiral

around the core bar means. The means for conveying the liquid could be a cord wound in spiral around the core bar means, threads on the core bar means, or be provided by providing the core bar with a polygonal section and turned in spiral around its axis.

The surface of the channels could be corrugated in order to provide a whirl means for the liquid flowing along the tube. The rising gradient of the means for conveying the liquid in spiral and/or the rising gradient of the channel walls could be varying in relation to the heat to be transported from components to be cooled.

The invention also relates to a method of manufacturing an apparatus for transporting away heat from heated elements, comprising a block of a material having good thermal conductivity on to which the elements are provided in thermal contact, and channels in the block through which a liquid flows. The method is **characterized** by

a) providing a corrugated tube of a non-corrosive material against the liquid and having thin walls;

b) placing a core bar means having means for conveying the liquid in spiral in the centre of the tube;

c) providing the tubes in the block in close contact with the material having good thermal conductivity.

Casting or sintering or compacting by powder the tubes of non-corrosive material in the material having good thermal conductivity could be made to bring them in close contact with it. As an alternative the steps a) and c) could be provided by forming a half channel in a surface of each of two aluminium blocks and providing an overlay in each half channel, thereafter placing the core bar means in one of the half channels; and then firmly joining the blocks having the half channels turned towards each other. The overlay could be performed by electrochemically providing it by an inert material, such as gold or silver.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and for further objects and advantages thereof, reference is now made to the following description of examples of embodiments thereof - as shown in the accompanying drawings, in which:

FIG 1	shows a first embodiment a liquid channel, in duplicate, in an apparatus according to the invention, i.e. in a side view and a partly sectional view at the inlet or outlet of the channel;
FIG 2	shows a second embodiment of a channel for liquid in a block;
FIG 3	shows a third embodiment of a channel for liquid in a block;
FIG 4	illustrates a method to provide the channels in a block;
FIG 5	illustrates a fourth embodiment of a channel for liquid in a block;
FIG 6	illustrates a fifth embodiment of a channel for liquid in a block.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIG 1, a water supply tube 1 supplies a liquid, for example water, to several parallel inlet channels, of which only two, 3 and 4, are illustrated. The upper one 3 in FIG 1 is a side view and the lower one 4 is shown having its outer wall in section and its connection to the tube 1 also shown in section.

Each outer tube part 5 and 6 for the inlets 3 and 4, respectively, for connection to the supply tube 1 has a smooth configuration and is inserted in an opening in and sealed tightened to it. A corrugated channel 7 and 8 is connected to the tube parts 5 and 6, respectively. A corrugation provides an extended surface of the channel walls towards the liquid.

The channels 7 and 8 could be provided in a material 9 having very good thermal conducting properties. This material could be a heat dissipating substrate, and then the channels 7 and 8 could be cast, or fastened in some other way, such as sintering or compacting of powder, directly in such a material. However, in order to get the corrugated surface of the channel, the channel could preferably first be provided as a tube having a thin corrugated wall, which then is cast in the substrate or fastened in some other way. An essential feature is that the liquid molecules are whirling in a corrugated channel inside the cold plate. The material of the tube should be non-corrosive to the streaming water forced through it. Thus other ways to provide whirling than a corrugated channel could be provided, such as lugs on the channel walls and/or the core bar and/or the cord.

However, if aluminium is chosen as the material 9, then, in accordance with an aspect of the invention, the corrugated channels could be tubes of a non-corrosive material, such as steel, preferably acid proof stainless steel, for example the stainless alloy 316L. The steel tubes 7, 8 do then have to have very thin walls, since this material is a bad thermal conductor in relation to aluminium. The steel tubes are provided in a firm thermal contact with the aluminium, preferably cast, but also sintered or compacted by powder or fastened in some other way, in an aluminium block 9, since aluminium is a very good thermal conductor.

Another way, shown in FIG 4, to create a firm thermal contact with a corrugated channel of non-corrosive material could be to form press, or cut or mill, a half channel 32, 33 in two aluminium blocks 30, 31, respectively, and create an overlay 34, 35, respectively, with the non-corrosive material in each half channel. The surface of the half channels could for example then be lined electrochemically with for example gold, silver or some other inert material. The two aluminium blocks with the half-channels are then firmly joined turned towards each other, after that the core bar with its winded cord has been placed in one of the half channels.

A core bar 10 having a smaller diameter than the channel 7, 8 is inserted in the centre of each channel 7, 8. A cord 11 of stainless steel, for example of the same alloy as the bar 10, is wired around the bar 10. At the inlet the bar 10 is provided through the tube 1 and tightened held by the tube wall. Instead, its end could be held by a screw joint or the like provided through the tube 1 wall.

The wired cord 11 fills the space between the core bar 10 and the corrugated wall of the channels 7, 8. When the channel is made of a stainless tube to be cast in the material 9, the tube is form stable in all directions as soon as it has been provided with the core bar 10 and the cord 11. This form stable tube is then cast in aluminium to form the cold plate. The core bar and the cord could be made by any material being form stable and non-corrosive to the streaming water. However, it is best to have the tube and the elements in it in the same material. Therefore, the best choice of material for the core bar and the cord is acid proof stainless steel.

The water pumped through each of the channels will flow in the space between the channel wall and the core in a rotating movement creating a turbulent flow across the corrugations of the channel walls. A great share of the water molecules in the water will repeatedly come into contact with the inside of the channel wall to absorb heat therefrom.

The embodiment in FIG 2 illustrates, that the cord 15 wired around the core bar 16 could have a varying rising gradient. This embodiment represents the best mode of the invention.

The section in FIG 2 is turned 90° in relation to the section in FIG 1. The tube 17 is made of very thin stainless steel and cast in a block 18 of aluminium. A component 19 to be cooled is provided in good thermal contact with the block 18. Inside the block, at the vicinity of the component 19, the rising gradient of the cord 15 is lower than the rising gradient of the cord where there is no heat-generating component in the vicinity.

The effect of lowering the rising gradient of the wired cord 15 in those sections of the cold plate, which have an extensive heat delivery from components, is that the rotating water could be forced to absorb heat more efficiently from the whole surface of the corrugated tube, due to an increasing centrifugal power forcing the water in the corrugations of the tube to move forwards in the stream direction in the tube.

In sections having a lower heat supply the rising gradient of the cord could have such a rising gradient that the cord only functions as a fixation means for the core bar within the tube 17. This feature provides the lowest possible fall of pressure per unit of length of the tube, and thus an optimal function could be obtained of the entire cold plate.

The meaning of having a core bar 10 or 16, together with the cord wired around it, has two purposes. One purpose is thus to hold the corrugated tube 17 or 7 in a form stable position during the time, it is cast, or fastened in some other way, in the aluminium. Casting is to be preferred in order to ensures a good thermal contact between the thin steel tube and the surrounding aluminium block, since a very good thermal contact is provided by the fact that aluminium has a higher thermal expansivity than acid proof steel. When the aluminium charge is cooling down a strong pressure is created towards the surface of the tube.

Another purpose is to provide a turbulent flow of the water pumped through it. The turbulence causes the water molecules to come into contact with the tube wall. Since the tube wall is very thin the heat transmitted from a heat producing component 19 (in FIG 2) through the aluminium block is easily transmitted across the thin steel wall and absorbed instantly by the molecules in the turbulently moving water. If the tube only should be corrugated and have the core bar, then some part of the water should be streaming in the centre space between the tube and the core bar. Some part of the water could then be standing in the corrugations of the tube. This gives a

worse efficiency than to have a cord wired around the core bar giving a spiral formed path for the water. The corrugations then provide the turbulence of the streaming water, which makes this cold plate so utterly efficient.

FIG 3 shows an embodiment in which the tube has different corrugations along its length. Thus instead of, or as a complement, having a varying rising gradient the corrugation of the tube 25 could be varied. The corrugation could be closer at positions near to a heat producing component 26 placed on the surface of the cold plate 27 and smoother at positions where there is little or no need for heat transport from a printed circuit, for example. If the material of the tube is extendable, the tubes could be provided in the adapted loops before cast. The tubes could then be adequately stretched and compressed. Thereafter, they are cast in the material having good heat transportation features, such as aluminium.

It is to be noted that varying rising gradients or varying corrugation along the water paths in a cold plate are preferably used in cases where the cold plate and the printed circuit or the like are to be made together in numerous series. Then it is economical to make the effort to adapt the heat transport to the circuits to be cooled.

FIG 5 illustrates that the core bar 41 itself provided in the block 42 could provide the rotation of the liquid by being provided with spiral threads 43 or the like along its length. The threads have a rising gradient adapted to the corrugation 44 of the channel.

It is also possible, as shown in FIG 6, to have a core bar 45 having a polygonal section and being screwed along its length. This will provide several, parallel channels inside the corrugated channel with whirling liquid.

Although the invention is described with respect to exemplary embodiments it should be understood that modifications can be made without departing from the scope thereof. Accordingly, the invention should not be considered to be limited to

the described embodiments, but defined only by the following claims which are intended to embrace all equivalents thereof.

WE CLAIM:

1. An apparatus for transporting away heat from heated elements, comprising a block (9; 18; 27) of a material having good thermal conductivity, on to which the elements are provided in thermal contact, and channels (7, 8; 17; 25) in the block, through which a liquid flows, are provided by tubes in close contact with the material having good thermal conductivity,
characterized in that
the material of the channel tubes are made in another material than the material in the block, the other material being non-corrosive against the liquid; and
the channel tubes have thin walls and are made of a material, which is allowed to have less thermal conductivity than the material in the block.

2. An apparatus according to claim 1, **characterized** in that the tubes are provided with whirl means (7, 8; 17; 25) for the liquid flowing along the tube.

3. An apparatus according to claim 2, **characterized** in that the whirl means (7, 8; 17; 25) in the tubes provide an extended cooling surface for the heat transport by the liquid.

4. An apparatus according to claim 3, **characterized** in that the extended cooling surface is provided by having the tube corrugated.

5. An apparatus according to anyone of the preceding claims, **characterized** in that the tubes are made by steel, preferably acid proof stainless steel.

6. An apparatus according to anyone of the preceding claims, **chracterized** in that the material having good thermal conductivity is aluminium.

7. An apparatus according to anyone of the preceding claims, **characterized** in that the tubes (8; 17; 25) of non-corrosive material are cast or sintered, plated, such as

electroplated, or compacted by powder in the material having good thermal conductivity.

8. An apparatus according to any of the preceding claims, **characterized** in that the tubes comprise core bar means (10; 16; 28) in its centre and means (11; 15; 29) for conveying the liquid in spiral around the core bar means.

9. An apparatus according to claim 8, **characterized** in that the means (11;15) for conveying the liquid is a cord wound in spiral around the core bar means (10; 16).

10. An apparatus according to claim 7, **characterized** in that the means (11;15) for conveying the liquid is threads on the core bar means.

11. An apparatus according to claim 7, **characterized** in that the means (11;15) for conveying the liquid is provided by providing the core bar with a polygonal section and turned in spiral around its axis.

12. An apparatus according to any of the claims 7 to 10, **characterized** in that the rising gradient of the means for conveying the liquid in spiral is varying in relation to the heat to be transported from components to be cooled.

13. An apparatus according to any of the claims 7 to 11, **characterized** in that the rising gradient of the channel walls is varying in relation to the heat to be transported from components to be cooled.

14. Method of manufacturing an apparatus for transporting away heat from heated elements, comprising a block (9; 18; 27) of a material having good thermal conductivity on to which the elements are provided in thermal contact, and channels (7, 8; 17; 5) in the block through which a liquid flows, **characterized** by

a) providing a corrugated tube of a non-corrosive material against the liquid and having thin walls;

b) placing a core bar means (10; 16; 28) having means (11; 15; 29) for conveying the liquid in spiral in the centre of the tube;
c) providing the tubes in the block in close contact with the material having good thermal conductivity..

15. Method according to claim 13, **characterized** by casting or sintering or compacting by powder the tubes (8; 17; 25) of non-corrosive material in the material having good thermal conductivity to bring them in close contact with it.

16. Method according to claim 13, **characterized** in that the steps a) and c) are provided by forming a half channel (32, 33) in a surface of each of two aluminium blocks (30, 31) and providing an overlay (34, 35) in each half channel, thereafter placing the core bar means in one of the half channels; and then firmly joining the blocks having the half channels turned towards each other.

17. An apparatus according to claim 15, **characterized** by electrochemically providing the overlay by an inert material, such as gold or silver.

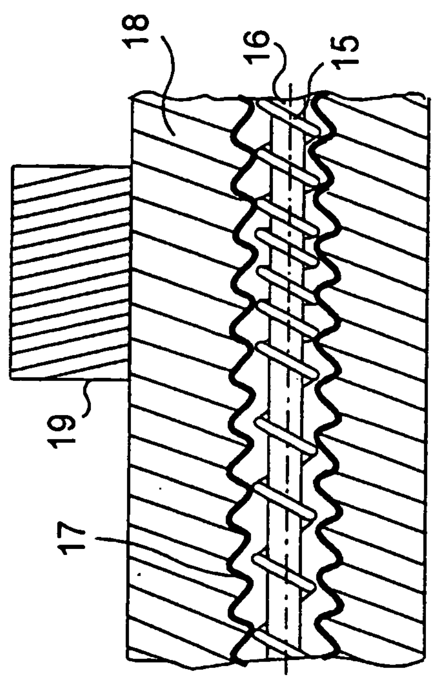

FIG 2

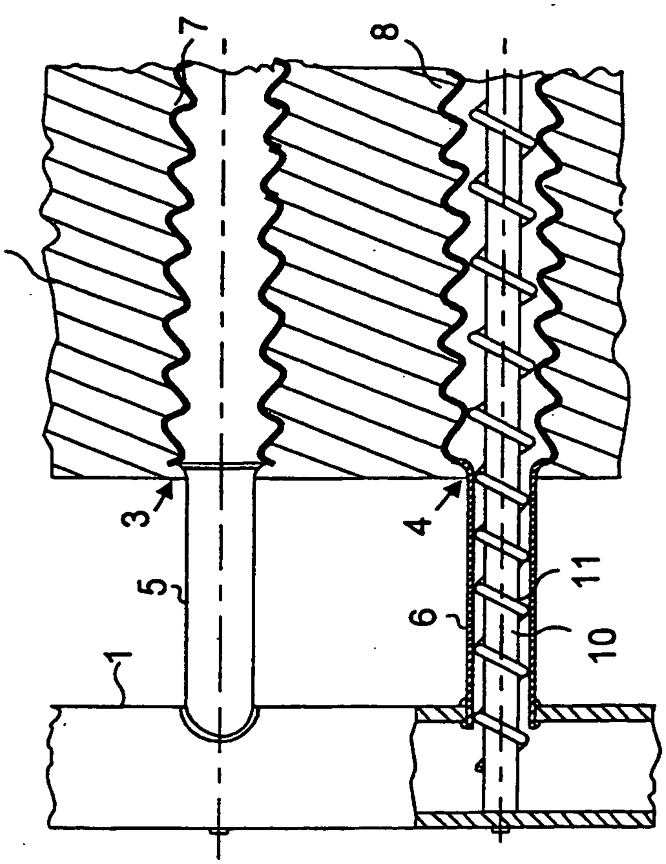

FIG 1

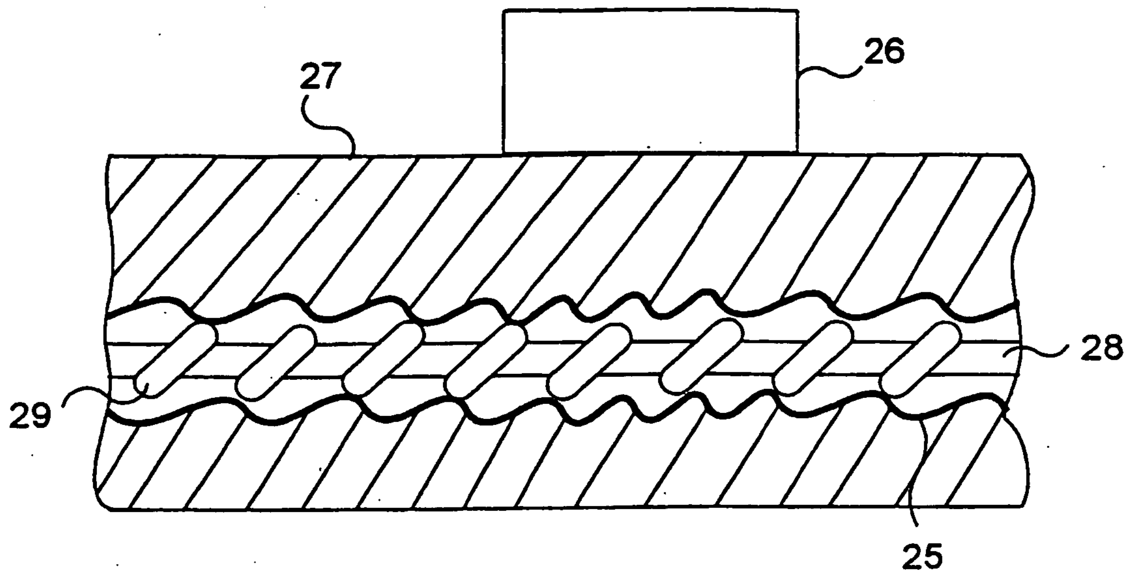

FIG 3

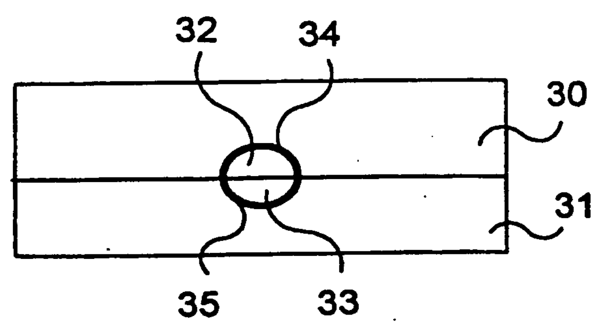

FIG 4

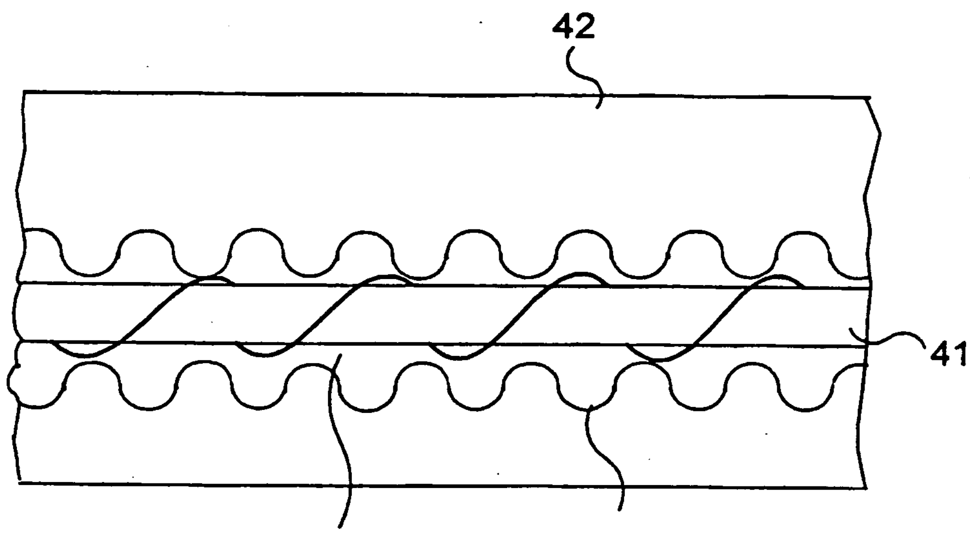

FIG 5

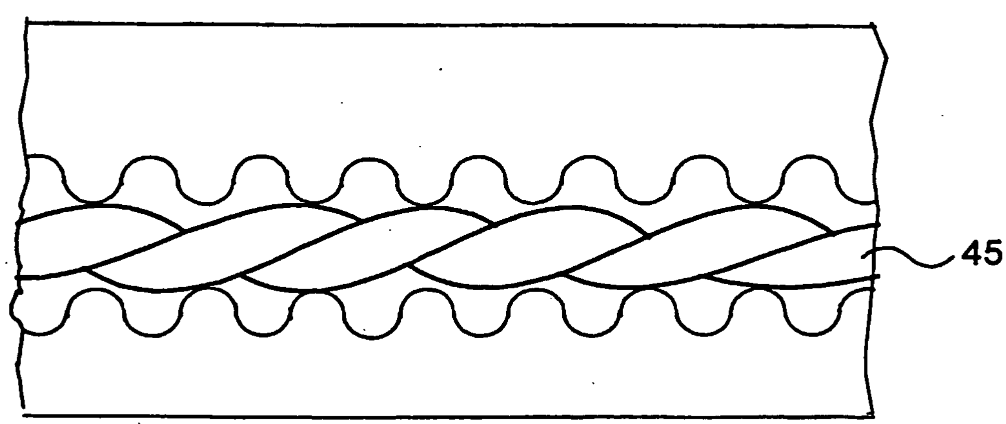

FIG 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/00388

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01L 23/373, H05K 7/20
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H01L, H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4747450 A (HIROO IKEGAME ET AL), 31 May 1988 (31.05.88), column 3, line 9 - line 19, figure 2, abstract	1,5-7
Y		2-4,8-13
A		14-17
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Y	DE 4421025 A1 (ABB PATENT GMBH), 21 December 1995 (21.12.95), column 2, line 58 - column 3, line 11, figures 2,4, abstract	2-4
A		1,5-17
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
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Date of the actual completion of the international search	Date of mailing of the international search report
8 May 2001	31-05-2001

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/00388

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 4301865 A1 (ABB MANAGEMENT AG), 28 July 1994 (28.07.94), column 3, line 11 - line 21, figure 4, claim 1	8-13
A		1-7,14-17
	--	
A	GB 1238462 B (THE ENGLISH ELECTRIC COMPANY LIMITED), 7 July 1971 (07.07.71), page 1, line 59 - line 82, figures 1,3	1-17
	--	
A	US 5826643 A (GEORGE TIPTON GALYON ET AL), 27 October 1998 (27.10.98), column 1, line 58 - column 2, line 30, abstract	1-17
	--	
A	US 4720981 A (ROBERT W. HELT ET AL), 26 January 1988 (26.01.88), column 2, line 60 - column 3, line 64, abstract	1-17
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INTERNATIONAL SEARCH REPORT
Information on patent family members

02/04/01

International application No.
PCT/SE 01/00388

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4747450 A	31/05/88	CA 1255811 A	13/06/89
		CN 1010067 B	17/10/90
		CN 86107015 A	25/11/87
		DE 3667117 D	00/00/00
		EP 0219692 A,B	29/04/87
		SE 0219692 T3	
		JP 1968684 C	18/09/95
		JP 6101524 B	12/12/94
		JP 62065444 A	24/03/87
DE 4421025 A1	21/12/95	NONE	
DE 4301865 A1	28/07/94	NONE	
GB 1238462 B	07/07/71	CH 466874 A	31/12/68
		FR 1571827 A	20/06/69
US 5826643 A	27/10/98	US 6173759 B	16/01/01
US 4720981 A	26/01/88	NONE	

Form PCT/ISA/210 (patent family annex) (July 1998)